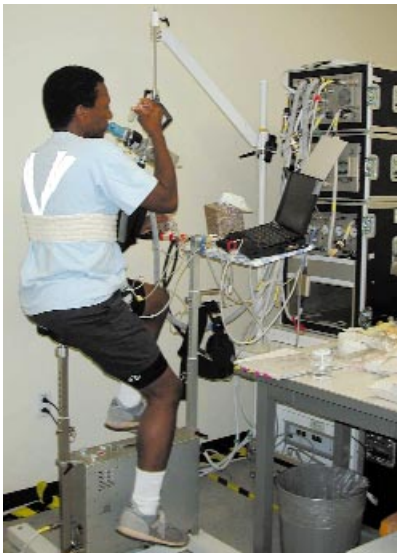
# Exploring Heart and Lung Function in Space

## ARMS Experiments

The Advanced Respiratory Monitoring System (ARMS) is a suite of monitoring instruments and supplies used to study the heart, lungs, and metabolism. Many experiments sponsored by the European Space Agency (ESA) will be conducted using ARMS during STS–107.

The near-weightless environment of space causes the body to undergo many physiological adaptations, and the regulation of blood pressure is no exception. Astronauts also experience a decrease in blood volume as an adaptation to microgravity.



ARMS measurements are taken during exercise, with astronaut subject Mike Anderson, in a ground-based test of the equipment.

Reduced blood volume may not provide enough blood pressure to the head during entry or landing. As a result, astronauts often experience light-headedness, and sometimes even fainting, when they stand shortly after returning to Earth.

To help regulate blood pressure and heart rate, baroreceptors, sensors located in artery walls in the neck and near the heart, control blood pressure by sending information to the brain and ensuring blood flow to organs. These mechanisms work properly in Earth's gravity but must adapt in the microgravity environment of space. However, upon return to Earth during entry and landing, the cardiovascular system must readjust itself to gravity, which can cause fluctuation in the control of blood pressure and heart rate. Although the system recovers in hours or days, these occurrences are not easily predicted or understood — a puzzle investigators will study with the ARMS equipment.

**Earth Benefits and Applications**

Studies with ARMS during STS–107 mean:

- Better understanding of the basic workings of the heart, lungs, and supporting systems
- Helping to develop new diagnostic tools for predicting illness and establishing rehabilitation techniques when problems do occur
- Applying rehabilitation techniques to treatment of patients confined to long-term bed rest.

In space, researchers can focus on aspects of the cardiovascular system normally masked by gravity. The STS–107 experiments using ARMS will provide data on how the heart and lungs function in space, as well as how the nervous system controls them. Exercise will also be combined with breath holding and straining (the Valsalva maneuver) to test how heart rate and blood pressure react to different stresses. This understanding will improve astronauts' cardiopulmonary function after return to Earth, and may well help Earthbound patients who experience similar effects after long-term bed rest.

**Project Scientist:** Dr. Andre Kuipers, European Space Agency
**Project Manager:** Michael Cork, European Space Agency
**Operations Engineer:** Marine LeGouic, European Space Agency

## Background Information

### Science

ARMS experiments will investigate pulmonary (lung), respiratory (airway), and cardiovascular (heart and blood vessels) changes during rest and exercise. ARMS instruments measure gas composition during inspiration and expiration, flow rate, mouthpiece pressure, heart rate, electrocardiogram (ECG), blood pressure, and respiratory rate — basic indications of how efficiently the lungs and heart are working. Astronauts undergo a range of health tests to make sure they are in peak physical condition before flight. Since preexisting health problems can be ruled out as a contributing factor, researchers can attribute changes to astronauts' cardiopulmonary systems to the effects caused by the space environment. Researchers use this information to create models that can be applied to future space travelers and humans on Earth.

The data and resulting insight from the continuing ARMS studies will help researchers develop rehabilitation techniques to treat patients confined to long-term bed rest.

### Hardware

The ARMS equipment, which is designed for non-invasive research on the respiratory, pulmonary, and cardiovascular systems, consists of three modules in SPACEHAB. The equipment contains two multi-gas analyzers, a flow meter, and a valve system into which the astronauts breathe. This system measures and records pressure, flow, and gas concentration during different activities performed by the astronauts. The system also includes a blood pressure cuff, an ECG, and a respiratory inductance plethysmograph, a device used to measure breathing frequency.

Multi-gas analyzers are instruments that measure the gas concentrations in inhaled and exhaled gas, including gases not found in air used to probe various aspects of heart and lung function. Respiratory flow meters measure gas flow and volume. The astronauts breathe into the respiratory valve system, which includes a pressure sensor inside the mouthpiece/airway to record the pressures generated during the straining maneuver. A gas supply subsystem provides the special respiratory gas mixtures used for both calibration and certain breathing tests. ECG instrumentation for monitoring the astronaut's heart rate, and blood pressure instrumentation for measuring peripheral arterial blood pressure are part of the equipment. A special belt will record rib cage expansion during the test. Environmental conditions of temperature, pressure, and relative humidity will be recorded using the ambient conditions monitoring system.

Using specific tracer gases which will then be measured by the ARMS hardware, it is possible to determine the lung volume and amount of blood pumped by the heart, among other things. All measurements gathered for the experiments are recorded onto a laptop computer and later downloaded for study.

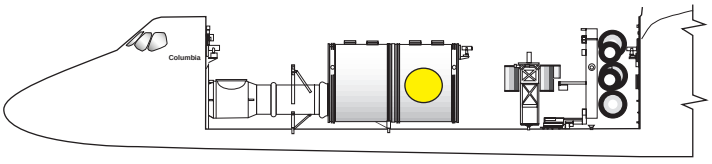
### Operations

During flight, STS–107 astronauts take measurements while performing activities. They must follow strict procedures for ARMS measurements. The ARMS laptop computer contains detailed instructions on all experiment protocols including resting and exercise protocols, as well as special breathing patterns and other techniques the astronauts must perform.

Researchers track changes in the respiratory and cardiovascular systems using the data collected before, during, and after flight.

### Earlier Studies

This flight furthers the ongoing study of heart and lung function from the European Space Agency's EUROMIR 95 mission and Spacelab.




Approximate location of this payload aboard STS–107.